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RRP Cable Damage Analysis for LARP Coils LQ 09 and LQ 13

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Abstract
Samples of cables used in coils LQ 09 and LQ 13 were prepared and analyzed for damage incurred during cabling. Samples were potted in epoxy, polished and analyzed. Six cross sections were used for each cable.

Sample Preparation Procedure

We began by soldering the LQ 09 and LQ 13 cables to hold the strands together during the potting, cutting, and polishing processes. Generally, if possible, the cables are soldered together while under tension on the cable machine. In this case, soldering under tension was impossible, so the cable was gently clamped one end while the length of the cable was soldered.

The cable was then cut into three pieces approximately 1.5 inches long, and these three pieces were potted in sample cups using to keep them straight. The cups were filled with epoxy, which cures overnight, and cut with a slow speed saw on both sides to ensure both cross sections were some distance away from the cut end of the cable piece. These cylindrical samples were then sanded to ensure that at least one triangular strand was visible in every case, because this is where damage appears most frequently. Fig. 1 shows a triangular strand.

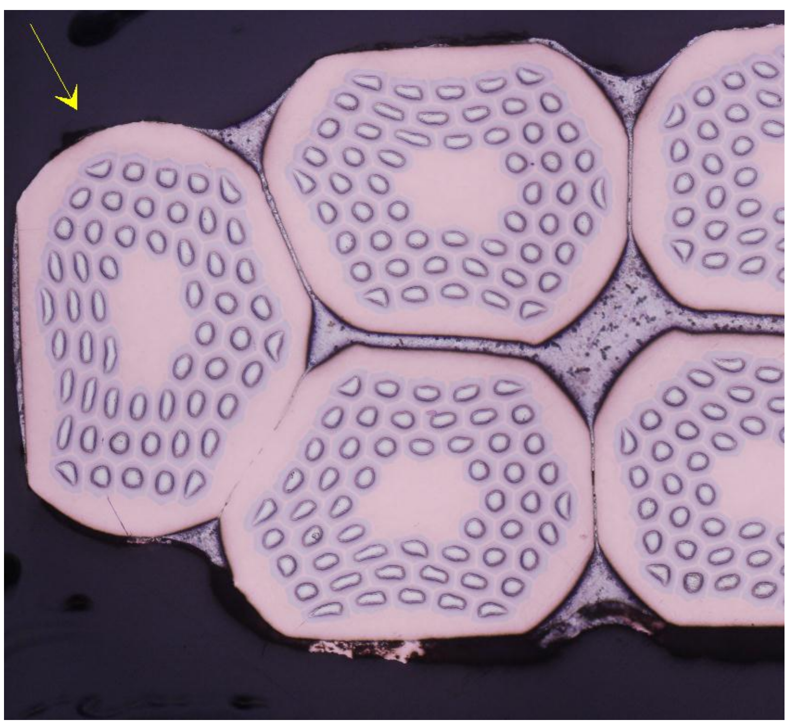

Figure 1: Triangular strand.

Both sides of the samples were then polished on an automatic polisher to a finish of 0.05 microns.

Microscope Analysis

Using a Nikon Eclipse MA200 microscope, we first determined at a 2.5X magnification level (25 times naked eye view) which side of the keystoned cable is the thin edge; this is usually reasonably obvious, as the thin edge is the most deformed side of the cable, as is shown in Fig. 2.

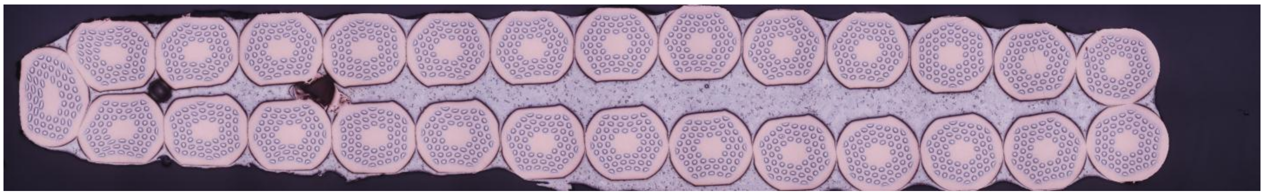

Figure 2: In this case, the thin edge of the cable is on the left – the strands on the left are flattened to a greater degree than those on the right.

The strands were then numbered 1-27, with strand one beginning on the thin edge. If applicable, the triangular strand on the thin edge was labeled as strand one, but for cases in which the triangular strand was on the thick edge, the strand in the top left corner of the thin edge was labeled as strand one. Examples of these orientations are shown in Fig. 3.

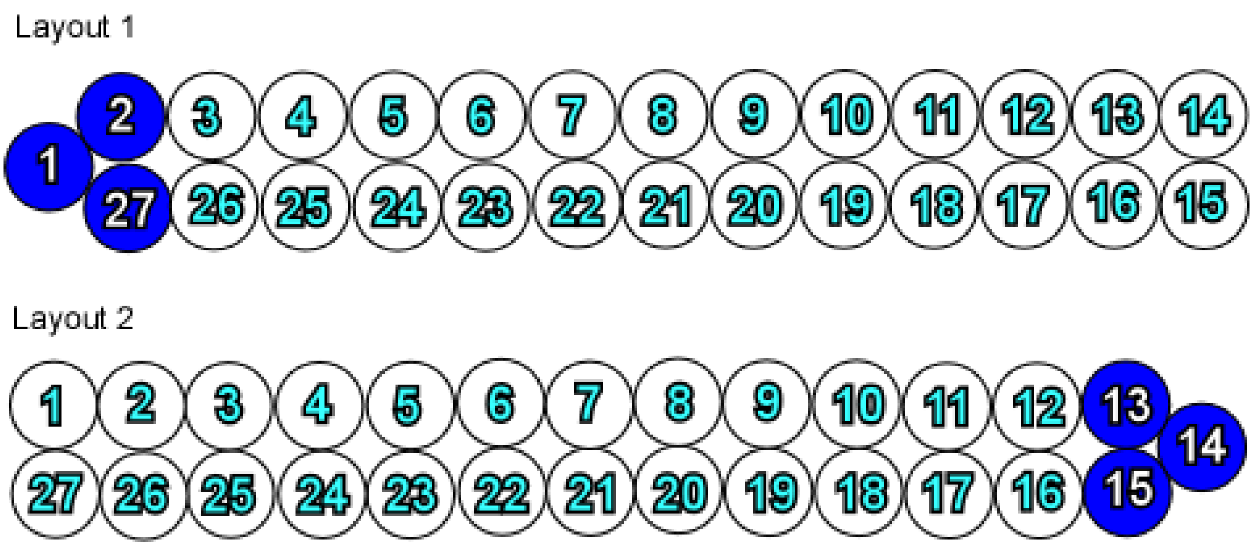

Figure 3. The thin edge of the cable is always rotated to the left side.

As is typical, we then checked for two types of damage: breakage and merging of subelements. Some examples of these types of damage and their questionable versions are pictured in Figures 4-7.

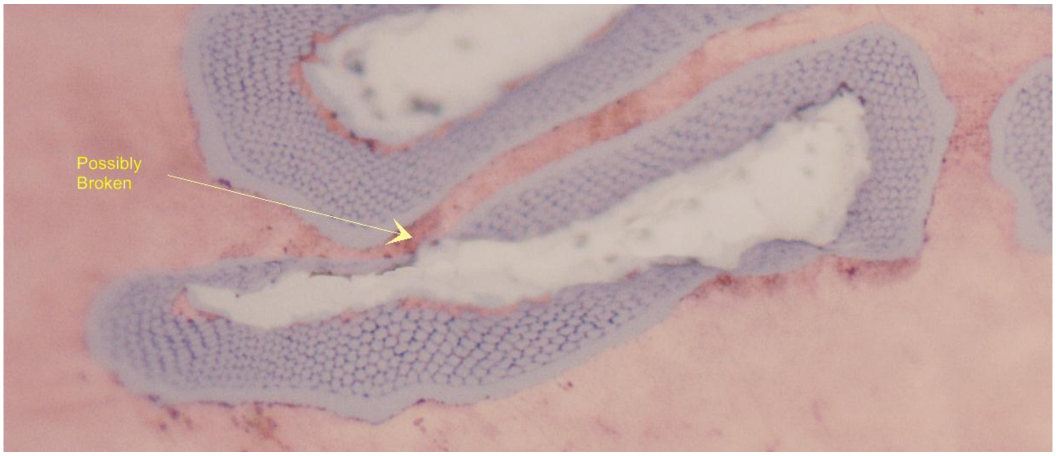

Figure 4: Possibly broken subelement.

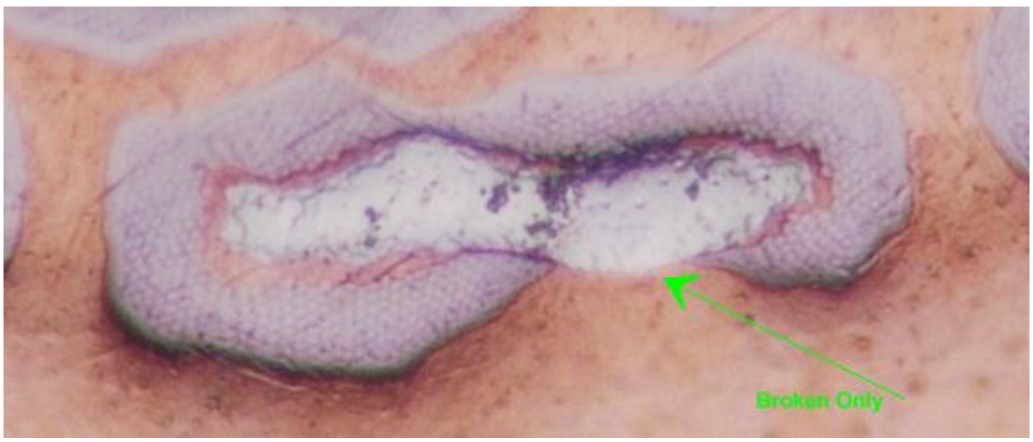

Figure 5: Broken subelement.

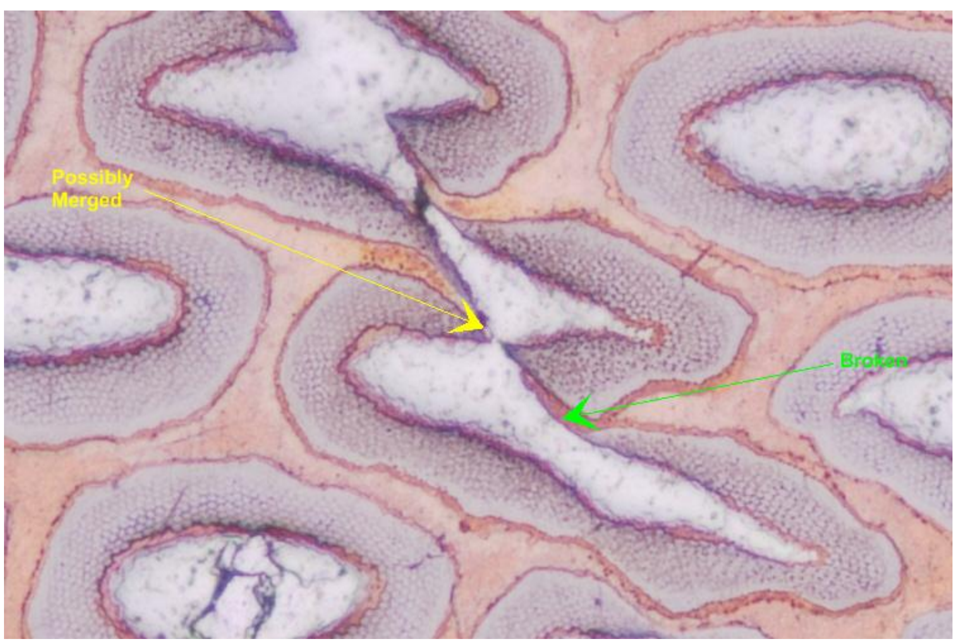

Figure 6: Broken and possibly merged subelements.

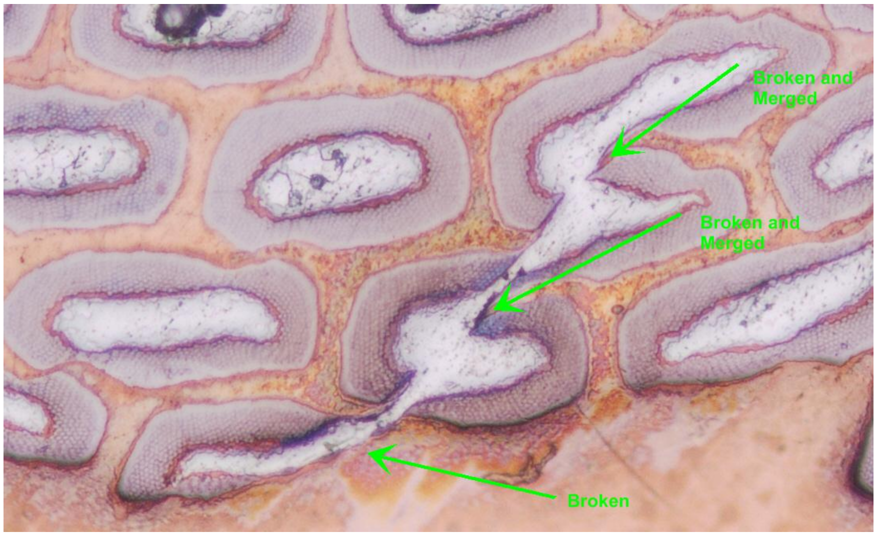

Figure 7: Broken and merged subelements.

We checked for this damage at magnifications of 20x and 50x (200 times naked eye view and 500 times naked eye view, respectively.) A quick check was done at the 20X level, followed by a more detailed check of any apparent problematic areas at the 50X level. These questionable areas are shown at the appropriate magnifications in Figures 8-11.

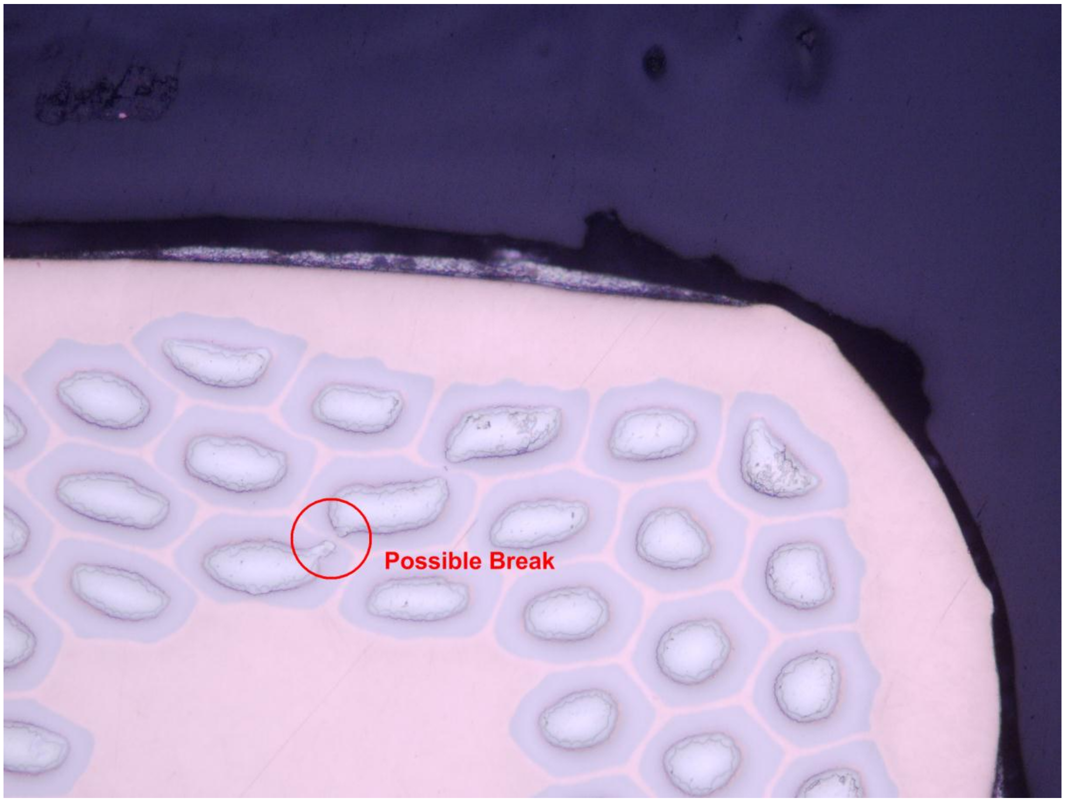

Figure 8: LQ 09 Cross Section 4, strand 1 at 20x magnification.

Figure 9: LQ 09 Cross Section 4, strand 1 at 50x magnification.

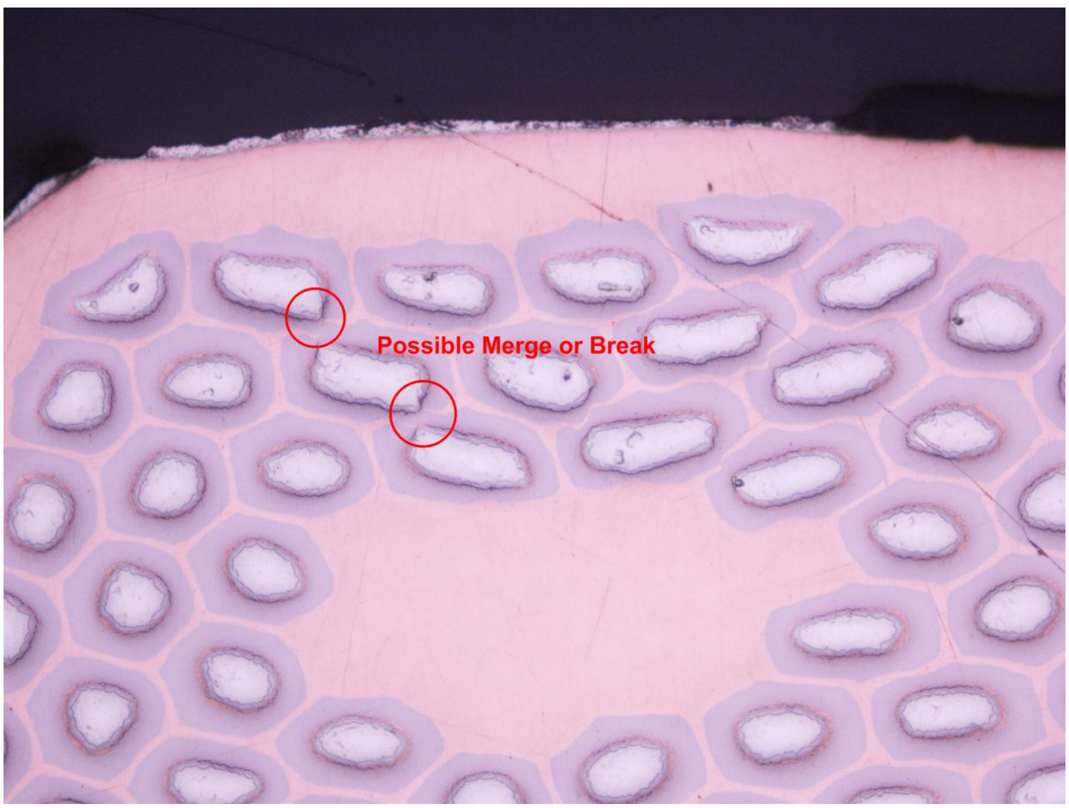

Figure 10: LQ 09 Cross Section 1, strand 1 at 20x magnification.

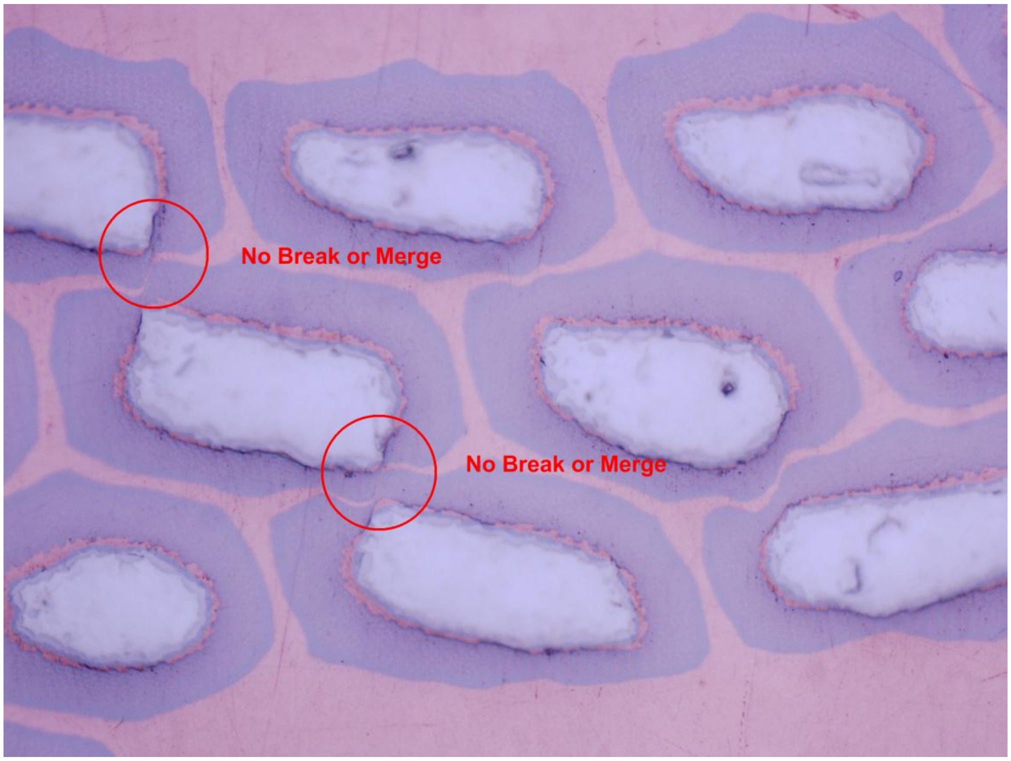

Figure 11: LQ 09 Cross Section 1, strand 1 at 50x magnification.

Results

The pictures above represent all of the apparent problematic areas in all 12 cross sections of the LQ 09 and LQ 13 cables. Only two areas with the possibility of damage were observed, and higher magnification clarified that no damage existed in either case. Although a complete lack of damage is not unheard of, even good cables generally show at least two to three damaged subelements when six cross sections are analyzed. A comparison to other recent 27-strand cables is shown below in Figure 12.

Cable ID	Keystoning	Strands used	No. cross sections analyzed	No. of Strands w/possible damage	Total No. broken subelements	Min/Max. No. merged subelements	No. Damaged Subelements
Cable 1	N	108/127	6	2	3	0/0	3
Cable 1	Y	108/127	6	0	0	0/0	0
Cable 2	Y	114/127	6	2	3	0/0	3
Cable 3	Y	114/127	6	4	9	3/5	9
Cable 4	N	108/127	6	0	0	0/0	0
Cable 4	Y	108/127	6	1	1	0/0	1
LQ 09	Y	54/61	6	0	0	0/0	0
LQ 13	Y	54/61	6	0	0	0/0	0

Figure 12: Table representing recent cable analysis.

The number of strands with possible damage represents the total number of strands in six cross sections that show either questionable or definite damage. Definitions of broken, merged, and questionable subelements are described above. The number of damaged subelements is indicative of the overlap between breakage and merging; this number is the total number of subelements that are found to be broken, merged, or both. The LQ 09 and LQ 13 cables were found to be in line with or slightly better than normal cables in terms of damage, as the table shows.

Conclusion

The cables used in the LQ 09 and LQ 13 coil are well-made, and show no signs of abnormal levels of damage.